

EDITORIAL ARTICLE.

BLOOD-PRESSURE IN SURGERY AND THE TREATMENT OF SURGICAL SHOCK.

IN the essay by Dr. Crile, of Cleveland, to which the Cartwright Prize of the Alumni Association of the College of Physicians and Surgeons of New York City was awarded in 1903, and which has been published in book form,¹ is to be found a continuation of the author's experimental research into surgical shock published in 1897. The present research is an attempt to ascertain by scientific experimental methods the effects of various drugs and methods of treatment in preventing or antagonizing or correcting the conditions already established by the previous experiments as constituting surgical shock. The present volume is divided into two separate parts. In the first are given in detail the protocols of 251 experiments upon 243 animals. In the second part the experimental data obtained are summarized and the conclusions are stated. It is in this second part that the surgeon will find most of interest, all the more so since the questions studied are of primal importance, and the conclusions enunciated are in many instances in contradiction of widely accepted practice.

It is essential that the reader keep in mind the distinction, and a most important practical one it is, which the author makes between the immediate sudden depression which may result from cardiac failure, from hæmorrhage, or from injuries of the vasomotor centre, and the more gradually developed depression which

¹ BLOOD-PRESSURE IN SURGERY. By GEORGE W. CRILE, A.M., M.D., Professor of Clinical Surgery, Western Reserve Medical College. Philadelphia: J. B. Lippincott Company, 1903. Large 8vo, pp. 422.

is due to the exhaustion of the vasomotor mechanism; impaired cardiac and respiratory action, hæmorrhage, anæsthesia, temperature, may all contribute in some degree to the final result; but the important thing is the vasomotor breakdown from overstimulation. To the first described condition the term *collapse* is appropriate; here there is a suspension of function rather than an exhaustion of centres. To the second condition alone is the term *shock* applied by Crile. Accepting, then, the author's statements that in shock the essential phenomenon is diminution of the blood-pressure, due to an exhaustion of the vasomotor centres, it is interesting to note the results of his experiments in the administration to animals suffering from shock of the drugs most commonly relied upon in surgical practice. Alcohol acted as a depressant; the more profound the shock the more marked was the depressing effect of alcohol. Nitroglycerin and amyl nitrite, also, were found to distinctly increase the rapidity of the decline in animals in deep shock. They increased shock instead of relieving it. Strychnine gave no better results; in any degree of shock, after the administration of a therapeutic dose of strychnine, the animals passed into deeper shock. Digitalis gave but little better results, for, although it usually caused a rise in the blood-pressure when given in various degrees of shock, it was found, however, that on the average cases of shock treated by digitalis did not live as long as the controls, that is, as long as similar animals under the same conditions to whom the drug was not given. This result seemed to be due to sudden cardiac failure from overstimulation. The author very justly remarks that there seems to be but a limited range of possibilities for heart stimulants in the condition of surgical shock. Stimulants acting upon the vasomotor, the cardiac, and other centres of the medulla are, on the whole, either inert or harmful.

The effects of adrenalin are more promising of good; in the normal animal in every degree of shock and collapse adrenalin administered intravenously caused a rise in the blood-pressure;

the force of the heart-beats was increased and the peripheral blood-vessels were contracted. But its effects are very transient, on account of the rapidity with which it is oxidized in the blood, so that its most effective method of administration was found to be by a continuous intravenous infusion in salt solution in strength of from 1 to 50,000 to 100,000. A burette, the rate of flow from which is controlled by a screw-cock attached to the rubber tube, may be used for its administration. Great caution must be exercised in its administration, for in an overdose it has a marked inhibitory effect upon the heart, and hence the circulatory phenomena should be under continuous observation. Whether it is a practical therapeutic agent, however, still remains to be established by its clinical use. Its inhibitory action upon the heart may be relieved by an injection of atropine.

Saline solution, intravenously or subcutaneously introduced, in every observation caused a rise in the blood-pressure, which was usually gradual, and was sustained in proportion to the degree of shock present. In the cases of moderate shock the gain in pressure was fairly well sustained; in deeper shock the rise was not so marked and not so well sustained; in case of the deepest shock the rise in the blood-pressure was not sustained beyond a certain time, even during the infusion. The solution is not retained in any considerable quantity in the blood-vessels, but is eliminated rapidly. Its range of usefulness is thus limited.

External pressure, as by bandages to the extremities, or by broadly applied pressure upon the abdomen, naturally suggests itself as a means of overcoming the accumulation of the blood in the veins resulting from vasomotor exhaustion, and of causing the blood to flow towards the heart. The real value of peripheral bandaging in raising and maintaining a rise in the blood-pressure was demonstrated in many of the experiments made. An ingenious device for the systematic application of external pressure was devised by the author, called by him a "pneumatic suit." This was constructed of a double layer of rubber cloth, enclosing

spaces to be inflated at will by a bicycle air-pump, whereby one or more of the limbs or the abdomen, separately or in any combination, might be subjected to pressure at will. The value of the apparatus to sustain the blood-pressure in conditions of shock, the author claims to have been strikingly demonstrated in repeated instances.

Morphine administered previous to the infliction of a traumatism, the author finds lessened to a considerable degree an animal's susceptibility to shock, and thereby made possible more extensive operations and procedures prolonged over a longer period of time. The clinical application of this finding is obvious.

The final summary of the author is as follows:

"In many instances the control of the blood-pressure is the control of life itself. Surgical shock is an exhaustion of the vasomotor centres. Neither the heart muscle, nor the cardiac centres, nor the respiratory centres are other than secondarily involved. Collapse is due to a suspension of the function of the cardiac, or of the vasomotor mechanism, or to hæmorrhage. In shock, therapeutic doses of strychnine are inert; physiologic doses are dangerous or fatal; if not fatal, increased exhaustion follows. Stimulants of the vasomotor centre are contraindicated. In shock, cardiac stimulants have but a limited range of possible usefulness and may be injurious. In collapse, stimulants may be useful because the centres are not exhausted. Saline infusion in shock has a limited range of usefulness; in collapse it may be effective. In shock it raises but cannot sustain the blood-pressure. Adrenalin acts upon the heart and the blood-vessels; it raises the blood-pressure in every degree of shock; it is rapidly oxidized by the solid tissue and by the blood; its effects are fleeting; it should be given continuously. In excessive doses there is a marked stimulation of the cardio-inhibitory mechanism; due caution must be exercised in its use; its clinical value still remains unproved."

The possible relationship of body temperature, either in the production of shock by its lowering, or in the prevention or

alleviation of shock by its elevation, does not seem to have as yet engaged the attention of Crile. Readers of the ANNALS OF SURGERY will doubtless recall the observations of Kinnaman on this point, as published in the December, 1903, issue of the Journal. In view of the conclusion of this last-named experimenter, that "temperature commands first place by its power of production, by its power of limitation, and by its power of amelioration of the composite condition,—shock," we shall look with interest for some future publication of Crile of results of his own experiments upon the effects of cold and heat upon shock. Kinnaman found that a rise of the temperature caused a rise in the blood-pressure and the respiratory rate (reduced in shock), with the result of a gradual amelioration of all the symptoms. If surgeons must abandon such time-honored agents as alcohol and strychnine, digitalis and nitroglycerin, in the treatment of shock, it will be a satisfaction to know that heat and friction are left to them.

It is obvious that in ordinary surgical work "pneumatic suits" are out of the question, while continuous infusions of adrenalin solutions are possible only in laboratory conditions. Saline infusions and subcutaneous injections are more generally practicable, and bandaging of the extremities is always available. It would appear as if these, with hot bottles and rubbings, were to constitute the therapeutic resources of the future against shock.

LEWIS S. PILCHER.